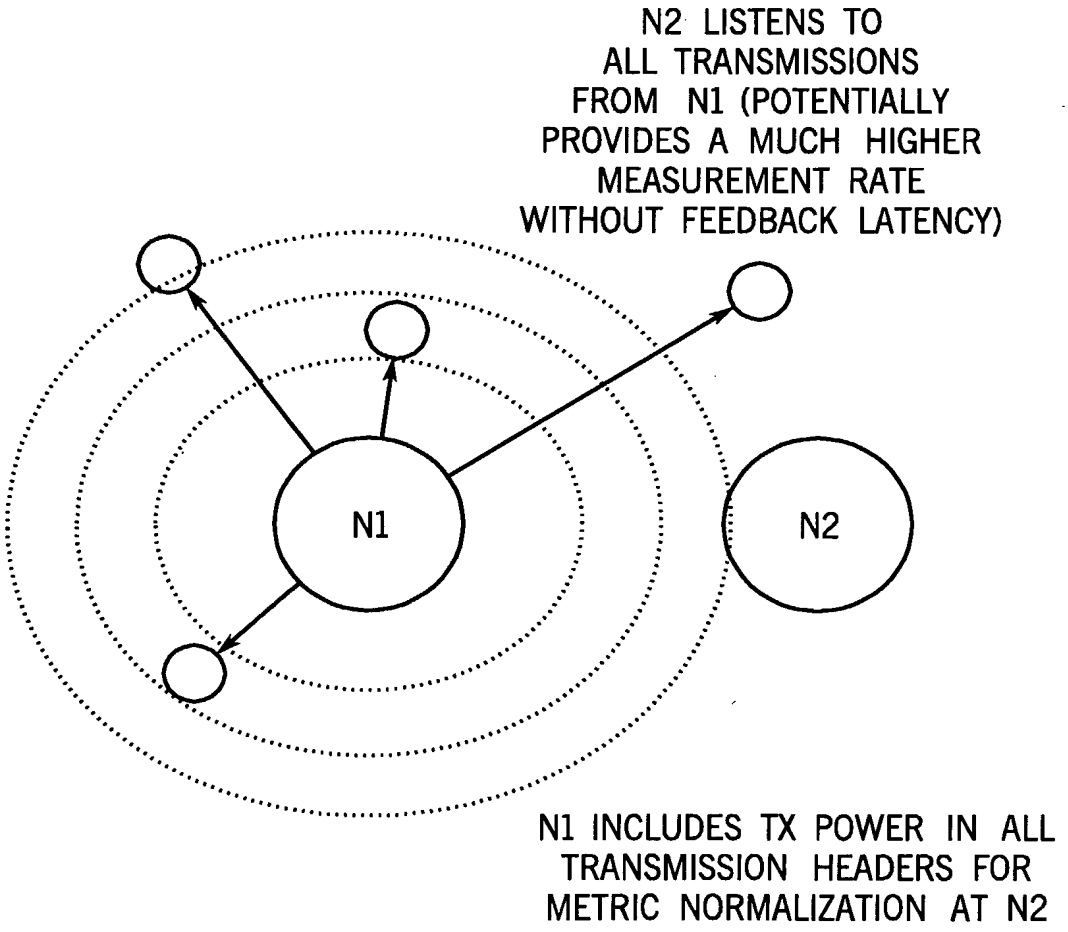
N2 LISTENS TO
ALL TRANSMISSIONS
FROM N1 (POTENTIALLY
PROVIDES A MUCH HIGHER
MEASUREMENT RATE
WITHOUT FEEDBACK LATENCY)
N1
N2
N1 INCLUDES TX POWER IN ALL
TRANSMISSION HEADERS FOR
METRIC NORMALIZATION AT N2

FIG. 1

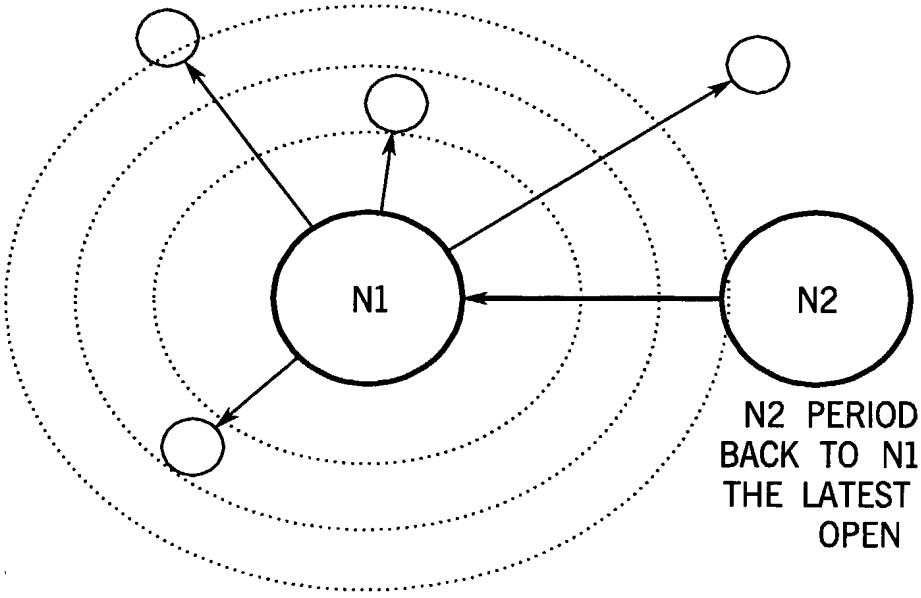
N1
N2
N2 PERIODICALLY TRANSMITS BACK TO N1 (MONITOR PACKET) THE LATEST OUTPUT FROM ITS OPEN LOOP FILTER.
THIS FORMS THE CLOSED LOOP FEEDBACK PATH BACK TO N1

FIG. 2

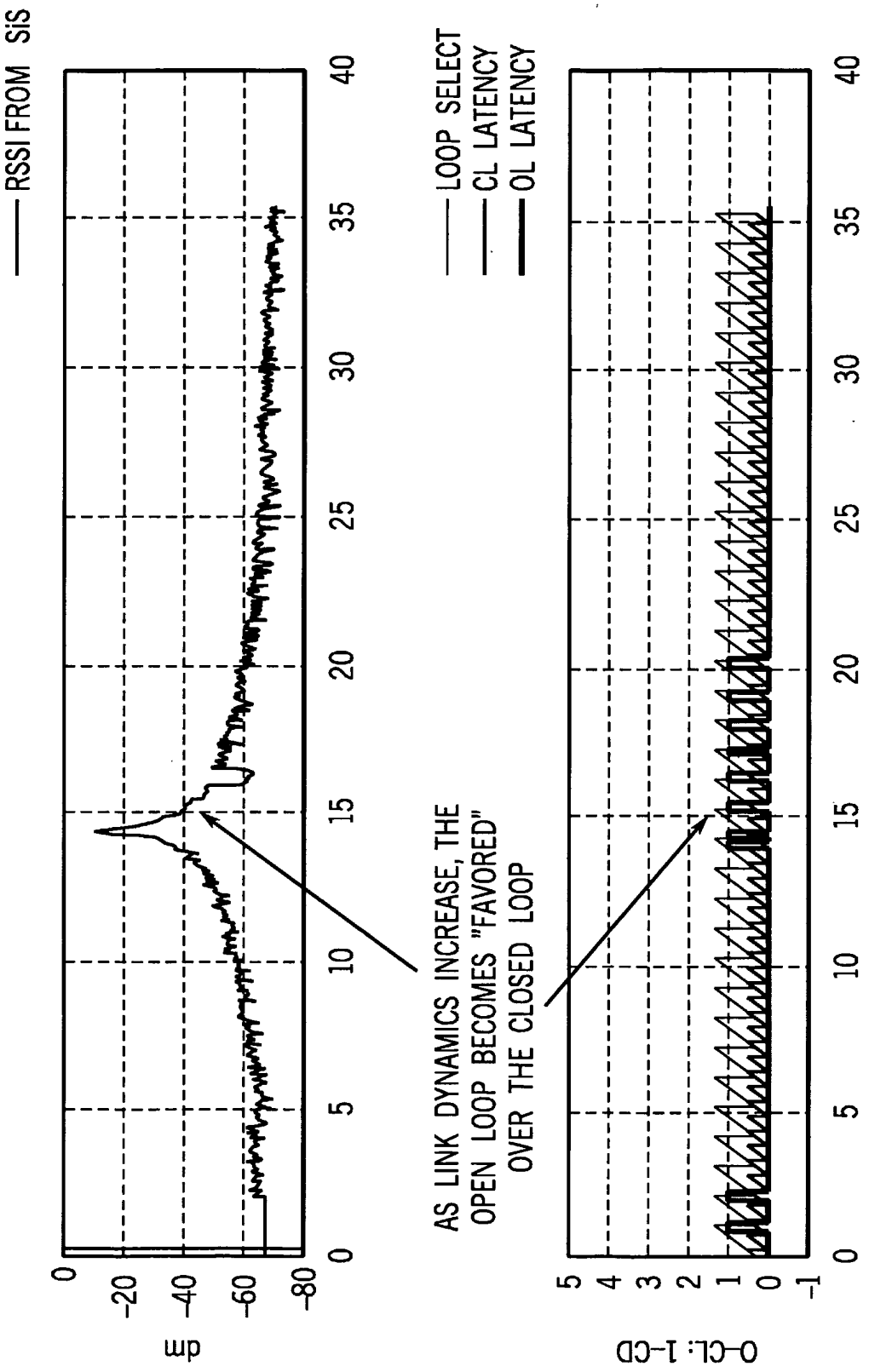
RSSI FROM SiS
dm
0
-20
-40
-60
-80
0
5
10
15
20
25
30
35
40
LOOP SELECT
CL LATENCY
OL LATENCY
AS LINK DYNAMICS INCREASE, THE
OPEN LOOP BECOMES "FAVORED"
OVER THE CLOSED LOOP
0-CL; 1-CD
5
4
3
2
1
0
-1

FIG. 3

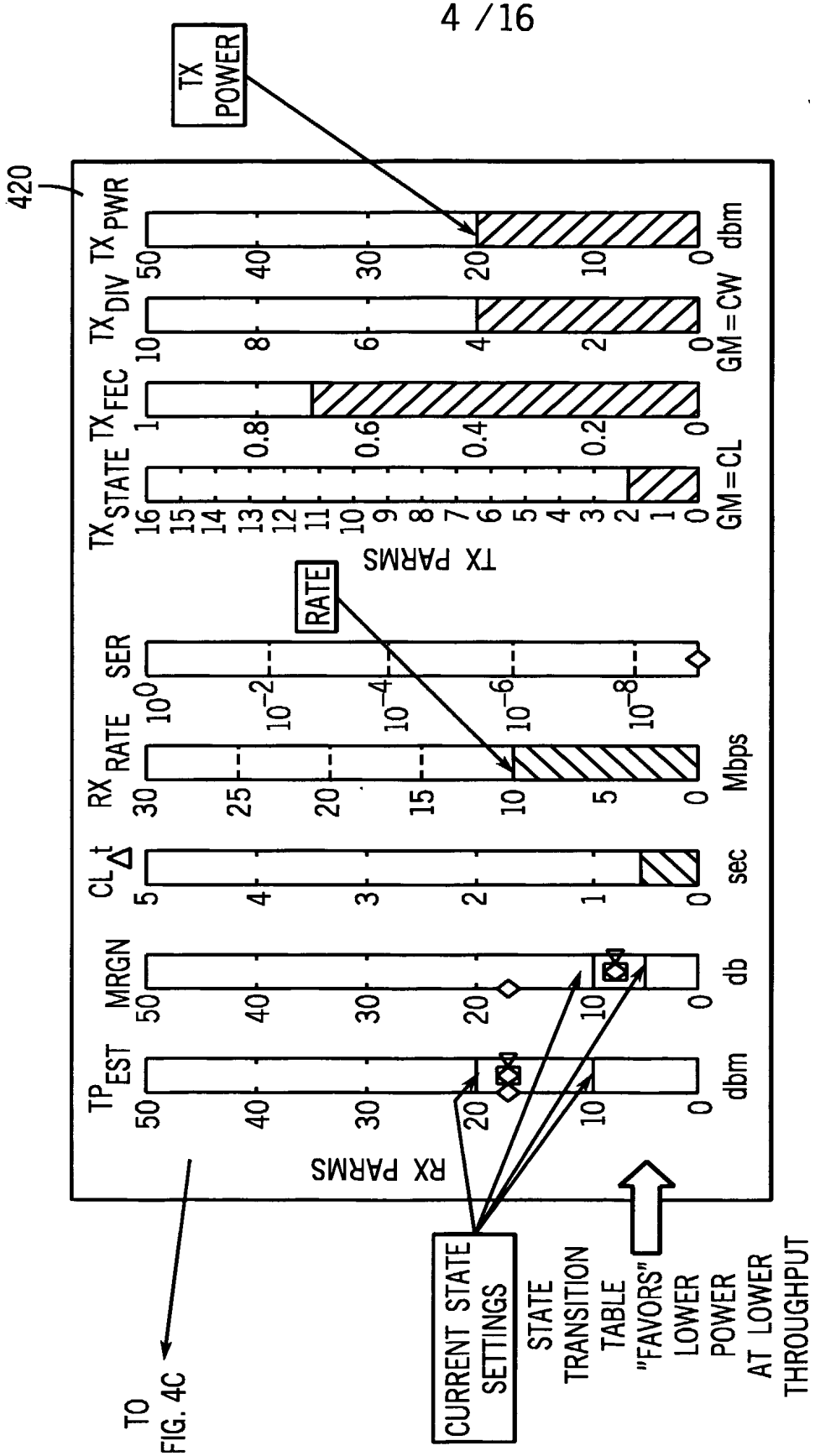
TX POWER
420
TX PWR
TX DIV
TX FEC
TX STATE
GM=CW
GM=CL
dbm
TX PARMS
RATE
SER
RX RATE
Mbps
CL Δt
sec
MRGN
db
TP EST
dbm
RX PARMS
TO FIG. 4C
CURRENT STATE SETTINGS
STATE TRANSITION TABLE "FAVORS" LOWER POWER AT LOWER THROUGHPUT

FIG. 4A

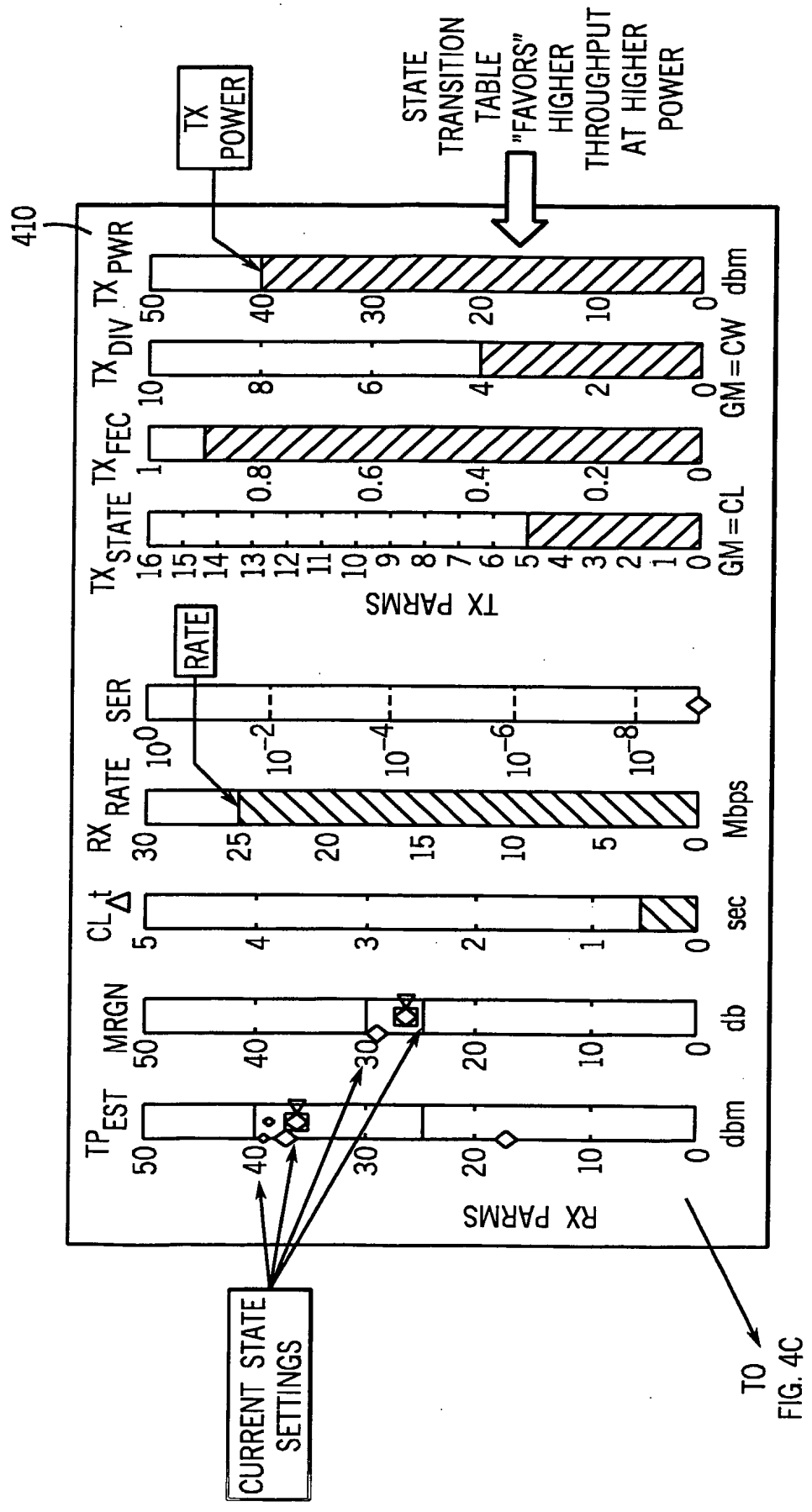
410
TX POWER
STATE TRANSITION TABLE "FAVORS" HIGHER THROUGHPUT AT HIGHER POWER
TX PWR
TX DIV
TX FEC
TX STATE
GM=CW
GM=CL
dbm
TX PARMS
RATE
SER
RX RATE
Mbps
CL Δt
sec
MRGN
db
TP EST
dbm
RX PARMS
CURRENT STATE SETTINGS
TO FIG. 4C

FIG. 4B

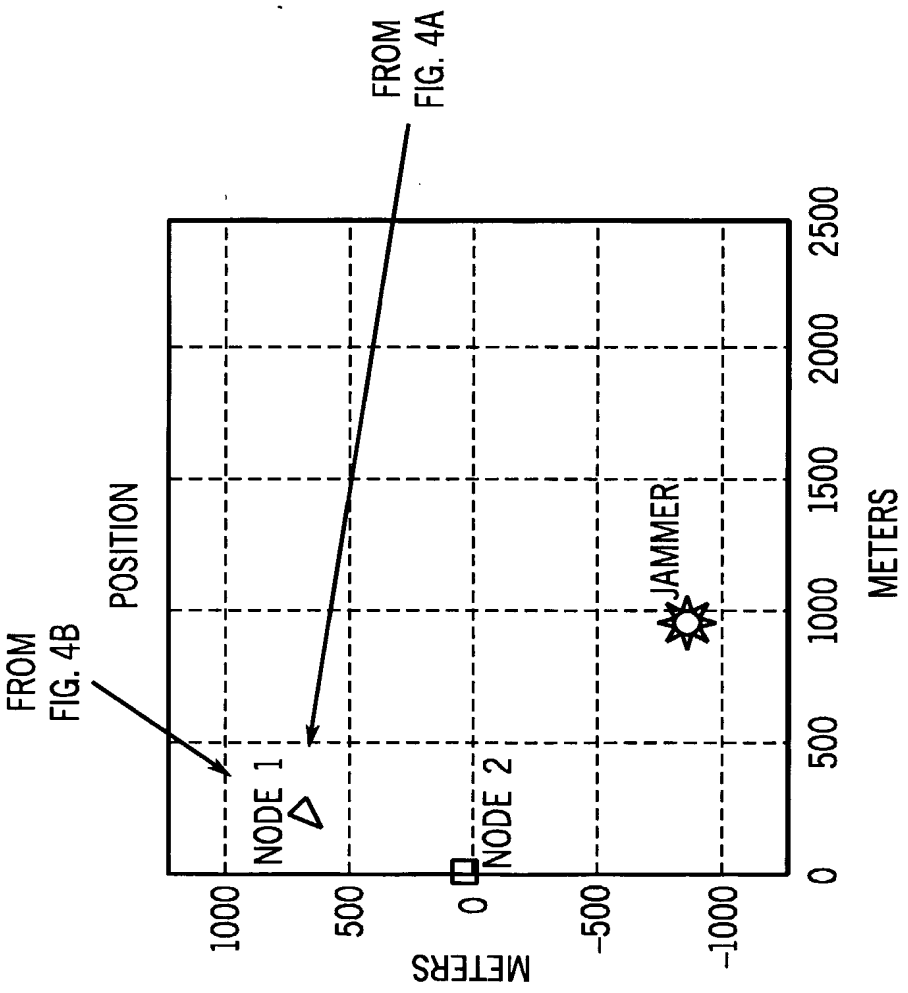
FROM FIG. 4A
FROM FIG. 4B
POSITION
NODE 1
NODE 2
JAMMER
METERS
1000
500
0
-500
-1000
METERS
0
500
1000
1500
2000
2500

FIG. 4C

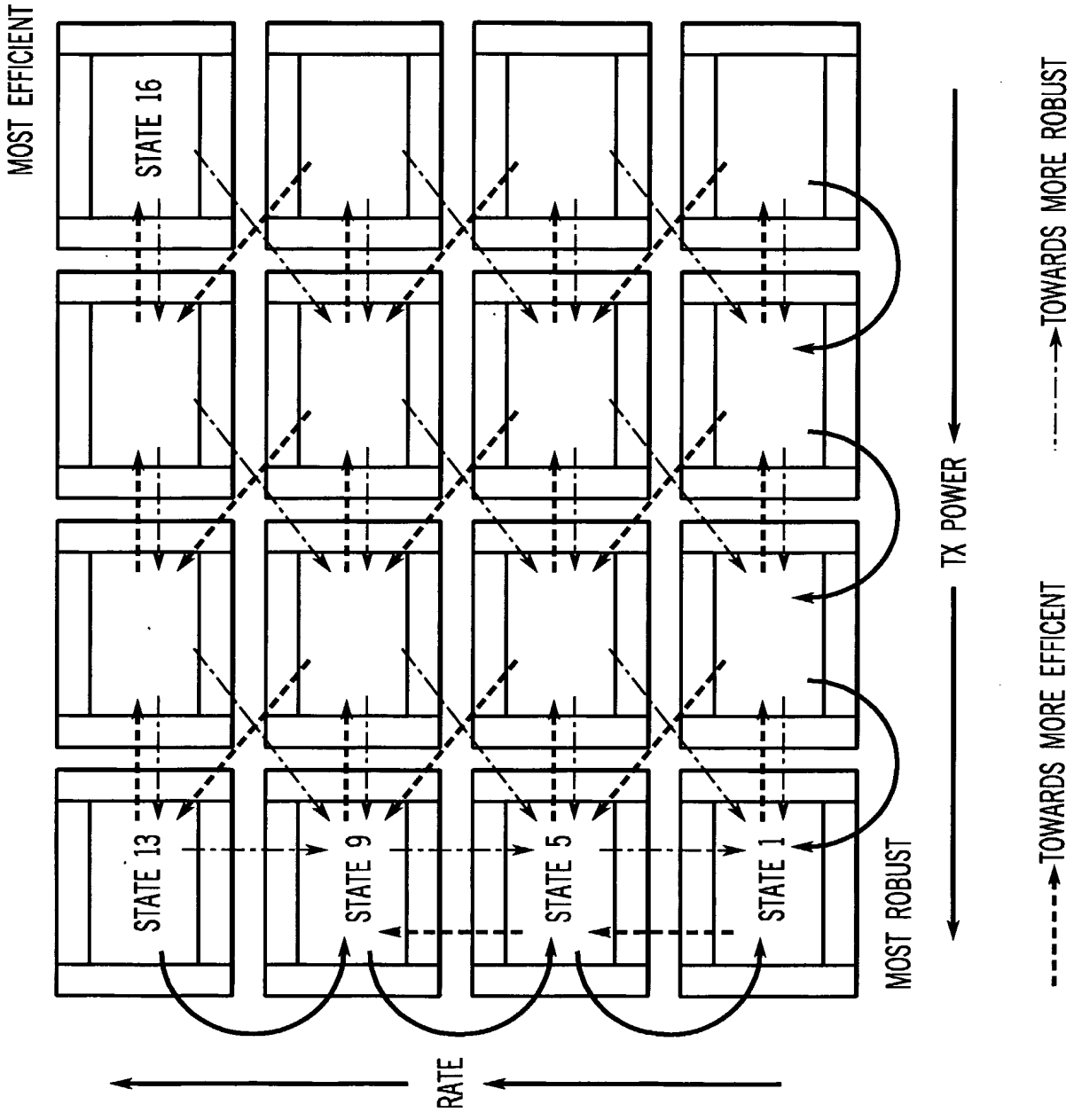
MOST EFFICIENT
STATE 16
STATE 13
STATE 9
STATE 5
STATE 1
MOST ROBUST
TX POWER
TOWARDS MORE ROBUST
TOWARDS MORE EFFICENT
RATE

FIG. 5

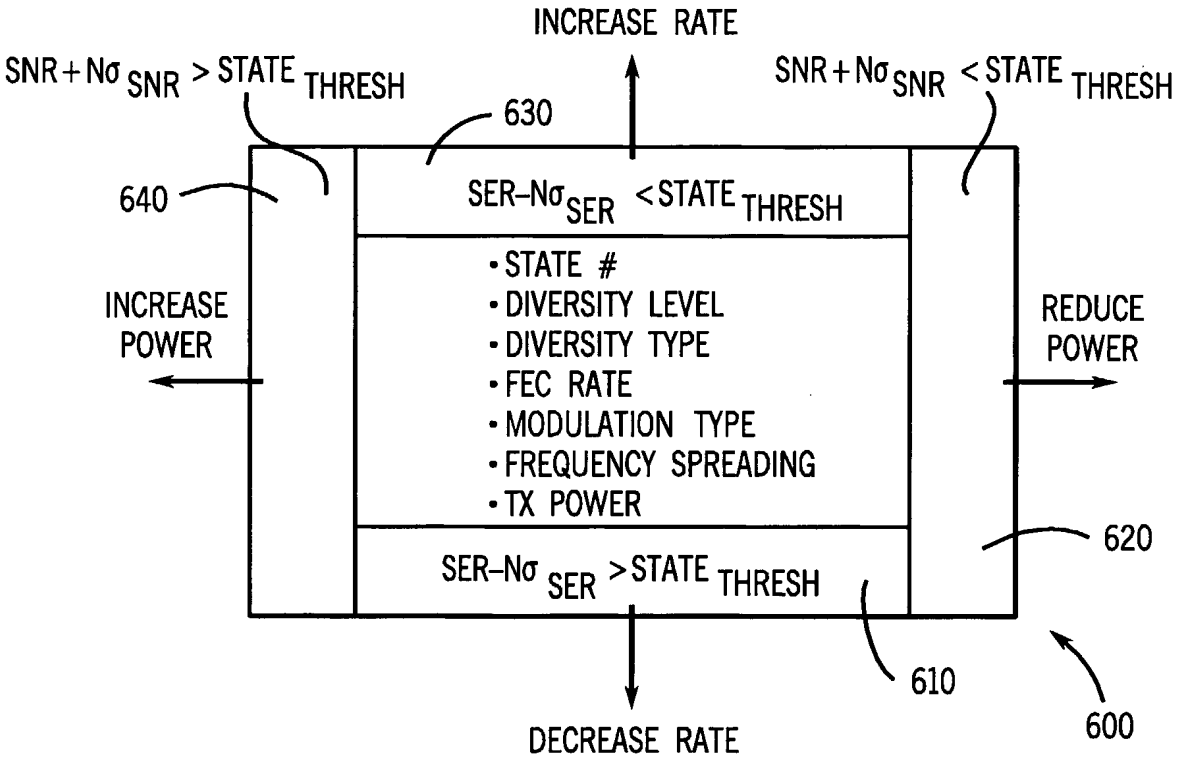
INCREASE RATE
SNR+Nσ SNR > STATE THRESH
SNR+Nσ SNR < STATE THRESH
630
640
SER-Nσ SER < STATE THRESH
• STATE #
• DIVERSITY LEVEL
• DIVERSITY TYPE
• FEC RATE
• MODULATION TYPE
• FREQUENCY SPREADING
• TX POWER
INCREASE POWER
REDUCE POWER
620
SER-Nσ SER > STATE THRESH
610
600
DECREASE RATE

FIG. 6

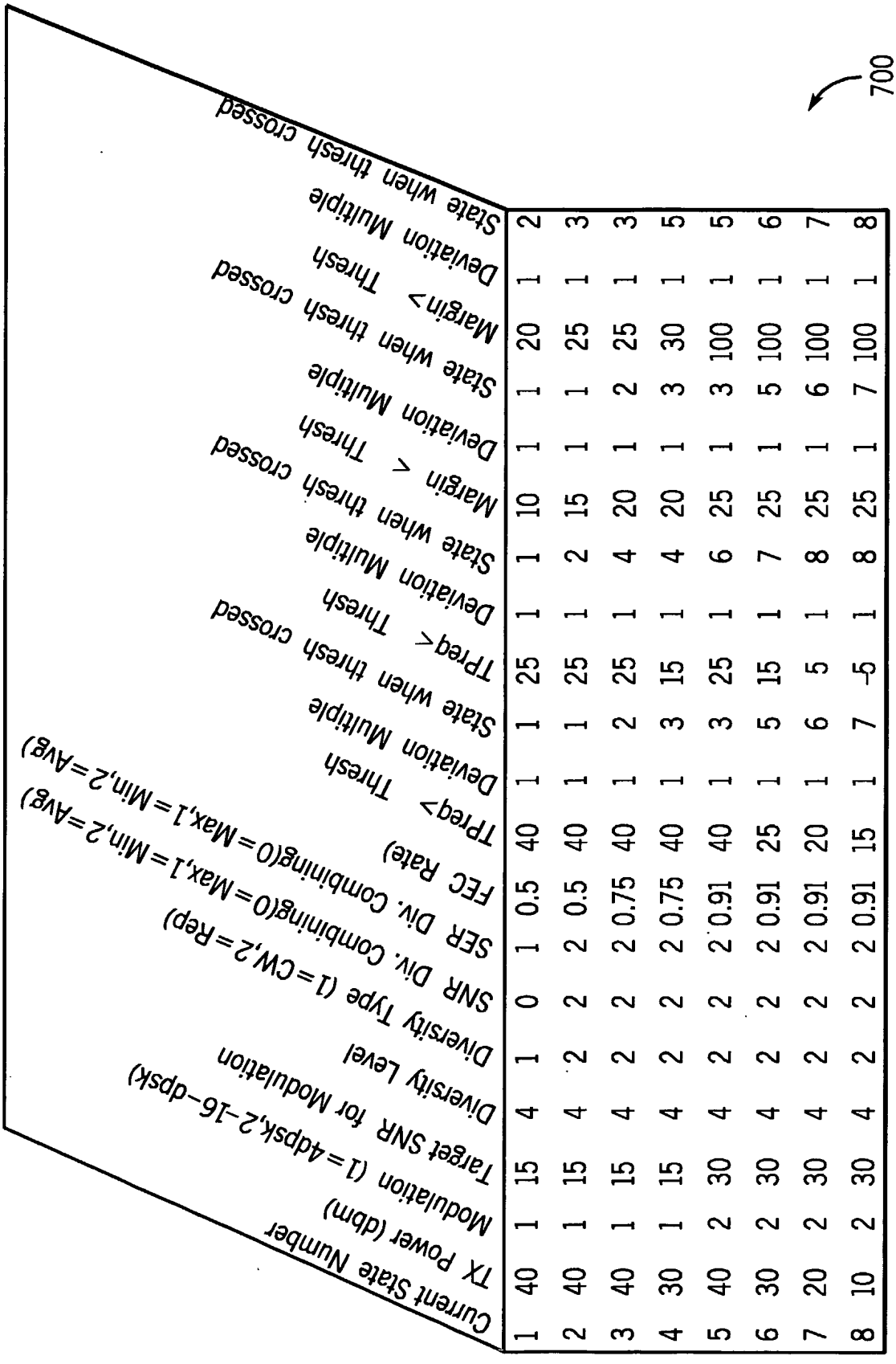
700
Current State Number
TX Power (dbm)
Modulation (1=4dpsk,2-16-dpsk)
Target SNR for Modulation
Diversity Level
Diversity Type (1=CW,2=Rep)
SNR Div. Combining(0=Max,1=Min,2=Avg)
SER Div. Combining(0=Max,1=Min,2=Avg)
FEC Rate)
TPreq> Thresh
Deviation Multiple
State when thresh crossed
TPreq< Thresh
Deviation Multiple
State when thresh crossed
Margin < Thresh
Deviation Multiple
State when thresh crossed
Margin > Thresh
Deviation Multiple
State when thresh crossed
1 40 1 15 4 1 0 1 0.5 40 1 1 25 1 1 10 1 1 20 1 2
2 40 1 15 4 2 2 2 0.5 40 1 1 25 1 2 15 1 1 25 1 3
3 40 1 15 4 2 2 2 0.75 40 1 2 25 1 4 20 1 2 25 1 3
4 30 1 15 4 2 2 2 0.75 40 1 3 15 1 4 20 1 3 30 1 5
5 40 2 30 4 2 2 2 0.91 40 1 3 25 1 6 25 1 3 100 1 5
6 30 2 30 4 2 2 2 0.91 25 1 5 15 1 7 25 1 5 100 1 6
7 20 2 30 4 2 2 2 0.91 20 1 6 5 1 8 25 1 6 100 1 7
8 10 2 30 4 2 2 2 0.91 15 1 7 -5 1 8 25 1 7 100 1 8

FIG. 7

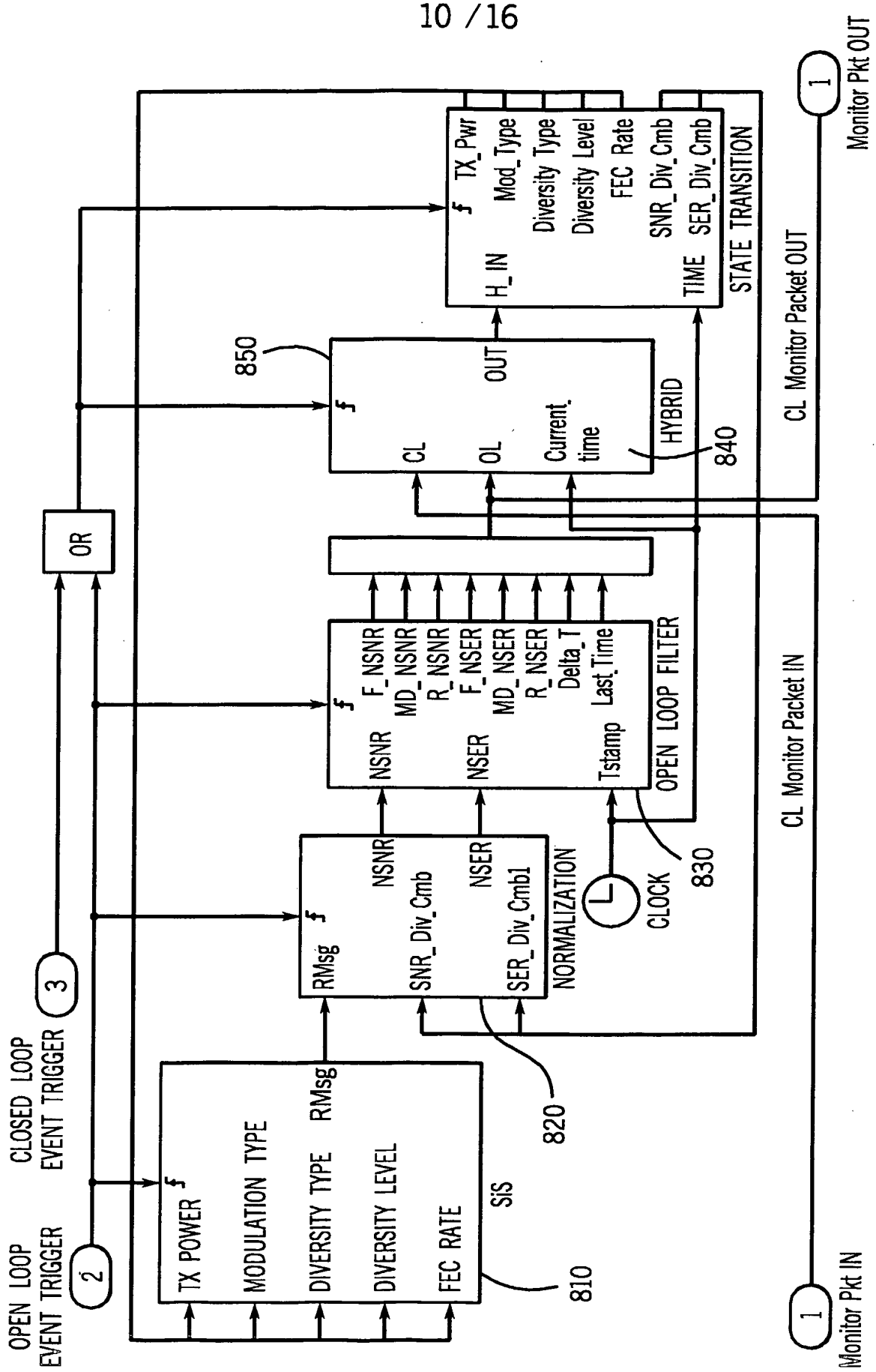
OPEN LOOP EVENT TRIGGER
CLOSED LOOP EVENT TRIGGER
OR
TX POWER
MODULATION TYPE
DIVERSITY TYPE
DIVERSITY LEVEL
FEC RATE
RMsg
SIS
810
820
RMsg
SNR_Div_Cmb
SER_Div_Cmb1
NORMALIZATION
NSNR
NSER
CLOCK
830
NSNR
NSER
Tstamp
F_NSNR
MD_NSNR
R_NSNR
F_NSER
MD_NSER
R_NSER
Delta_T
Last Time
OPEN LOOP FILTER
CL
OL
Current time
OUT
HYBRID
840
850
H_IN
TX_Pwr
Mod_Type
Diversity Type
Diversity Level
FEC Rate
SNR_Div_Cmb
SER_Div_Cmb
TIME
STATE TRANSITION
CL Monitor Packet OUT
CL Monitor Packet IN
Monitor Pkt OUT
Monitor Pkt IN

FIG. 8

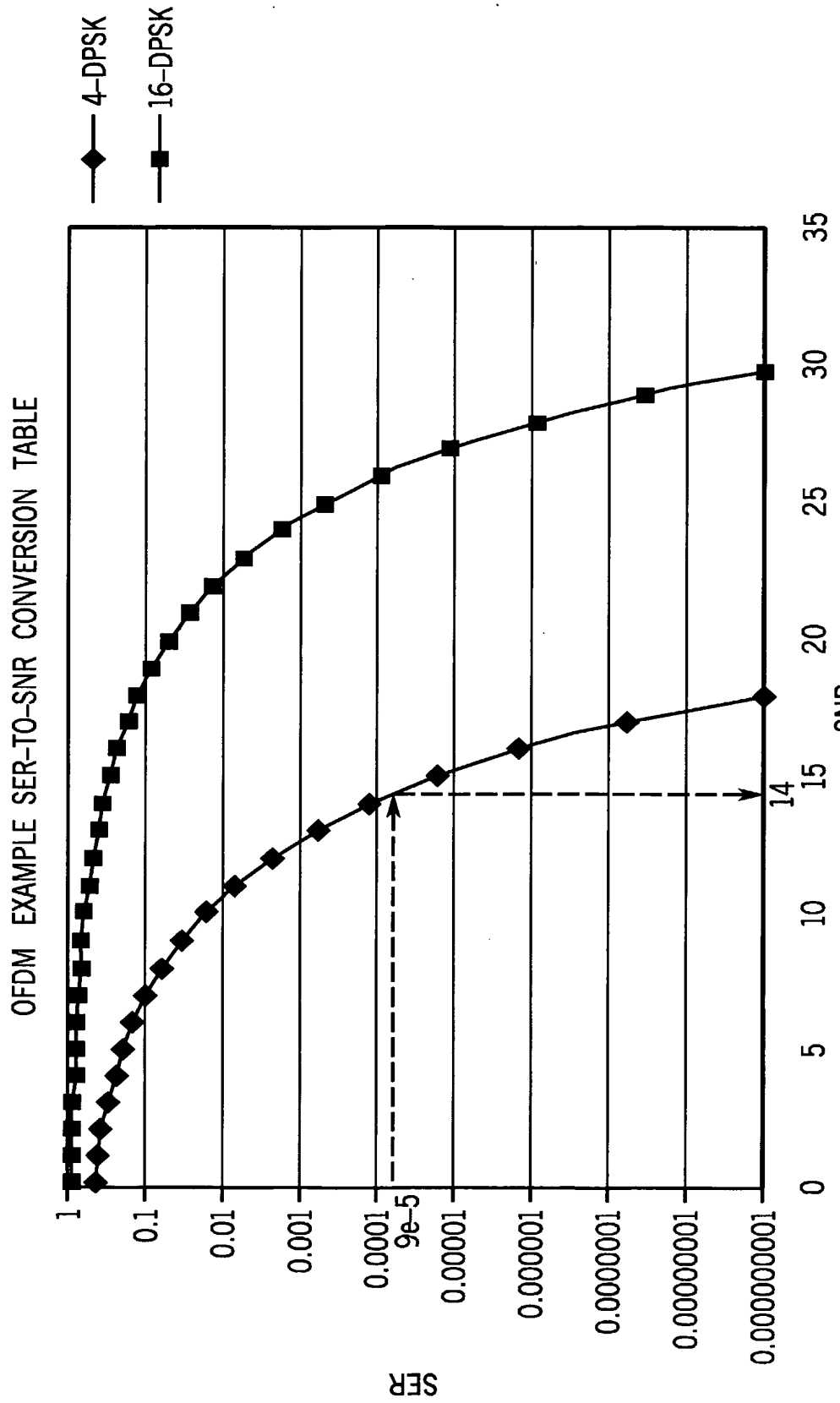
OFDM EXAMPLE SER-TO-SNR CONVERSION TABLE
4-DPSK
16-DPSK
SER
1
0.1
0.01
0.001
0.0001
9e-5
0.00001
0.000001
0.0000001
0.00000001
0.000000001
SNR
0
5
10
14
15
20
25
30
35

FIG. 9

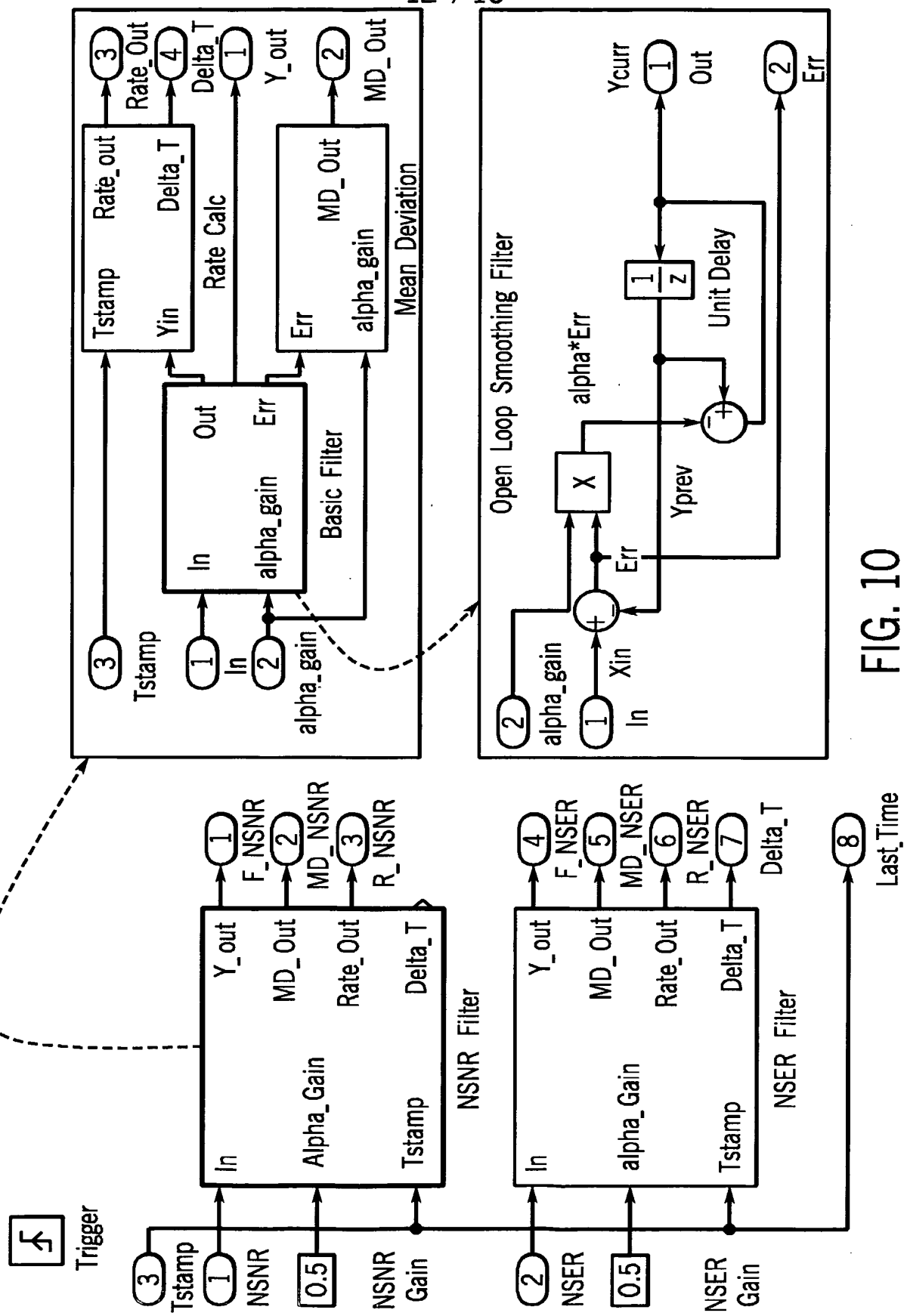
Trigger
Tstamp
NSNR
0.5
NSNR Gain
In
Alpha_Gain
Tstamp
NSNR Filter
Y_out
MD_Out
Rate_Out
Delta_T
F_NSNR
MD_NSNR
R_NSNR
NSER
NSER Gain
NSER Filter
F_NSER
MD_NSER
R_NSER
Last_Time
Mean Deviation
Tstamp
In
alpha_gain
Basic Filter
Out
Err
Rate Calc
Yin
Rate_out
Delta_T
MD_Out
Open Loop Smoothing Filter
Xin
alpha_gain
Err
alpha*Err
Yprev
Unit Delay
Ycurr
Out
Err

FIG. 10

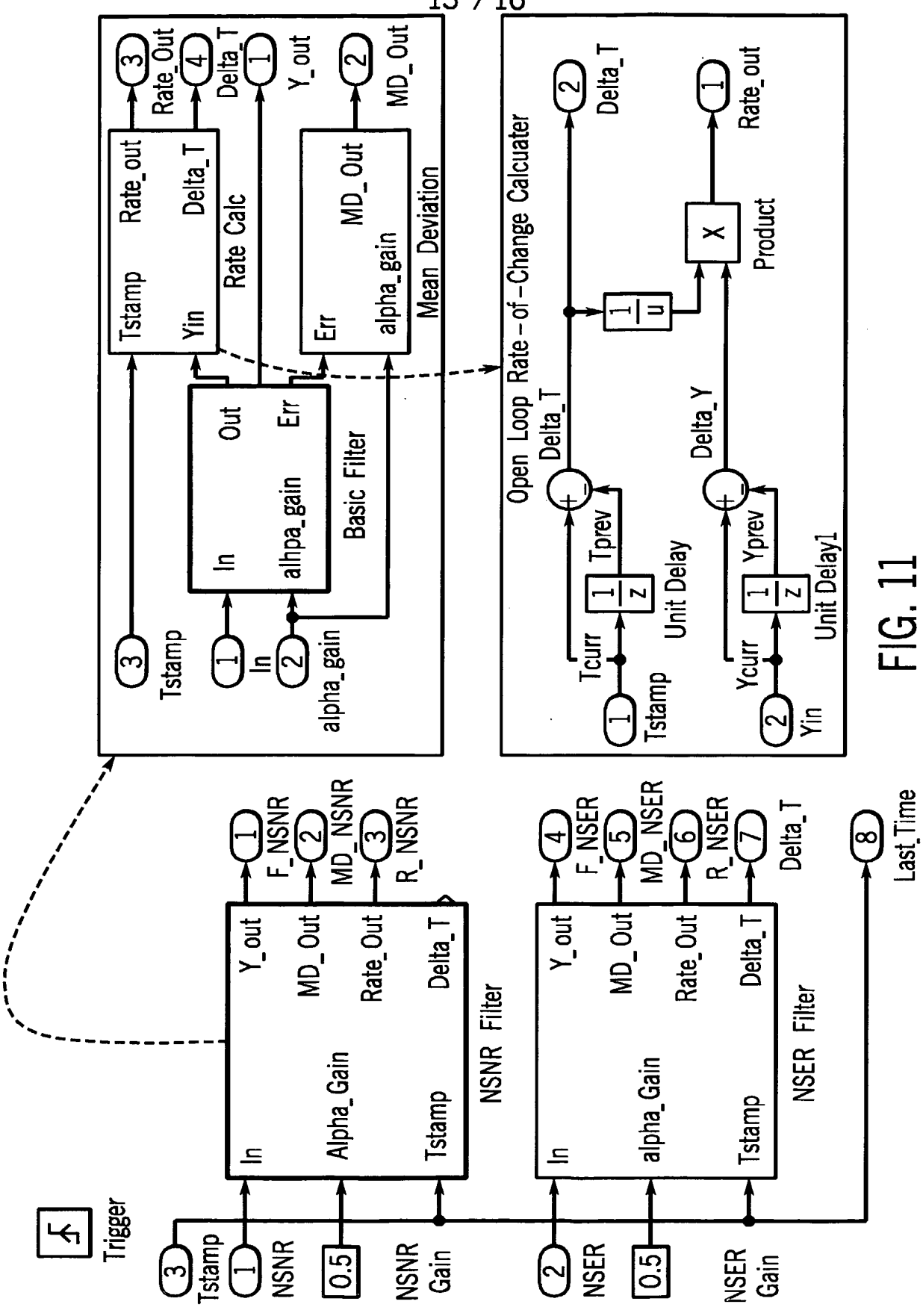
Trigger
Tstamp
NSNR
0.5
NSNR Gain
In
Alpha_Gain
Tstamp
NSNR Filter
Y_out
MD_Out
Rate_Out
Delta_T
F_NSNR
MD_NSNR
R_NSNR
NSER
NSER Gain
alpha_Gain
NSER Filter
F_NSER
MD_NSER
R_NSER
Last_Time
Tstamp
In
alpha_gain
Basic Filter
Out
Err
alhpa_gain
Tstamp
Yin
Rate Calc
Rate_out
Delta_T
Rate_Out
Delta_T
Y_out
Err
alpha_gain
Mean Deviation
MD_Out
MD_Out
Open Loop Rate-of-Change Calcuater
Tcurr
Tstamp
Unit Delay
Tprev
Delta_T
Ycurr
Yin
Unit Delay1
Yprev
Delta_Y
Product
Rate_out
Delta_T

FIG. 11

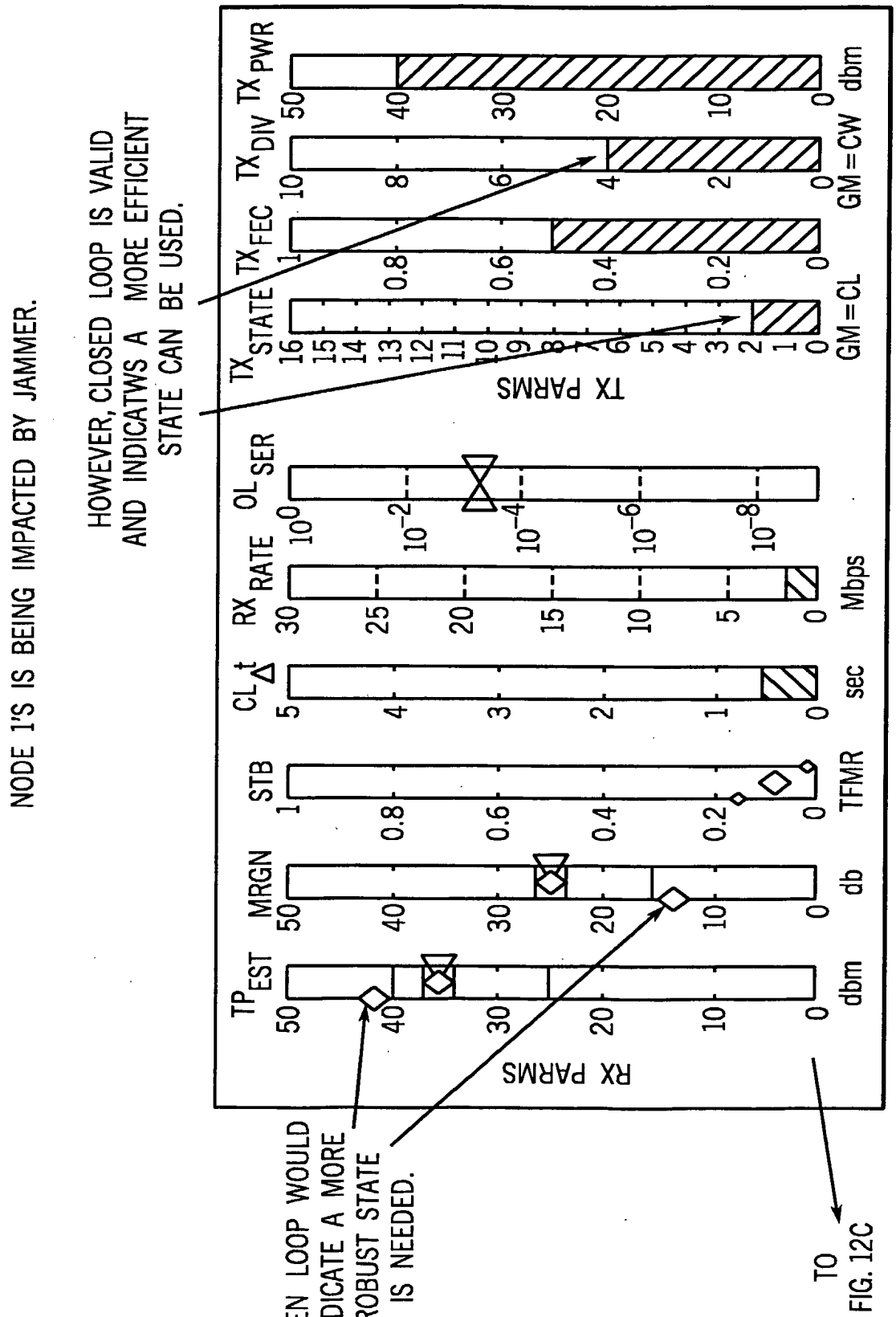
NODE 1'S IS BEING IMPACTED BY JAMMER.
HOWEVER, CLOSED LOOP IS VALID AND INDICATWS A MORE EFFICIENT STATE CAN BE USED.
OPEN LOOP WOULD INDICATE A MORE ROBUST STATE IS NEEDED.
TO FIG. 12C
NODE 1
RX PARMS
TX PARMS
TP_{EST}
MRGN
STB
$CL_{\Delta t}$
RX_{RATE}
OL_{SER}
TX_{STATE}
TX_{FEC}
TX_{DIV}
TX_{PWR}
dbm
db
TFMR
sec
Mbps
GM=CL
GM=CW

FIG. 12A

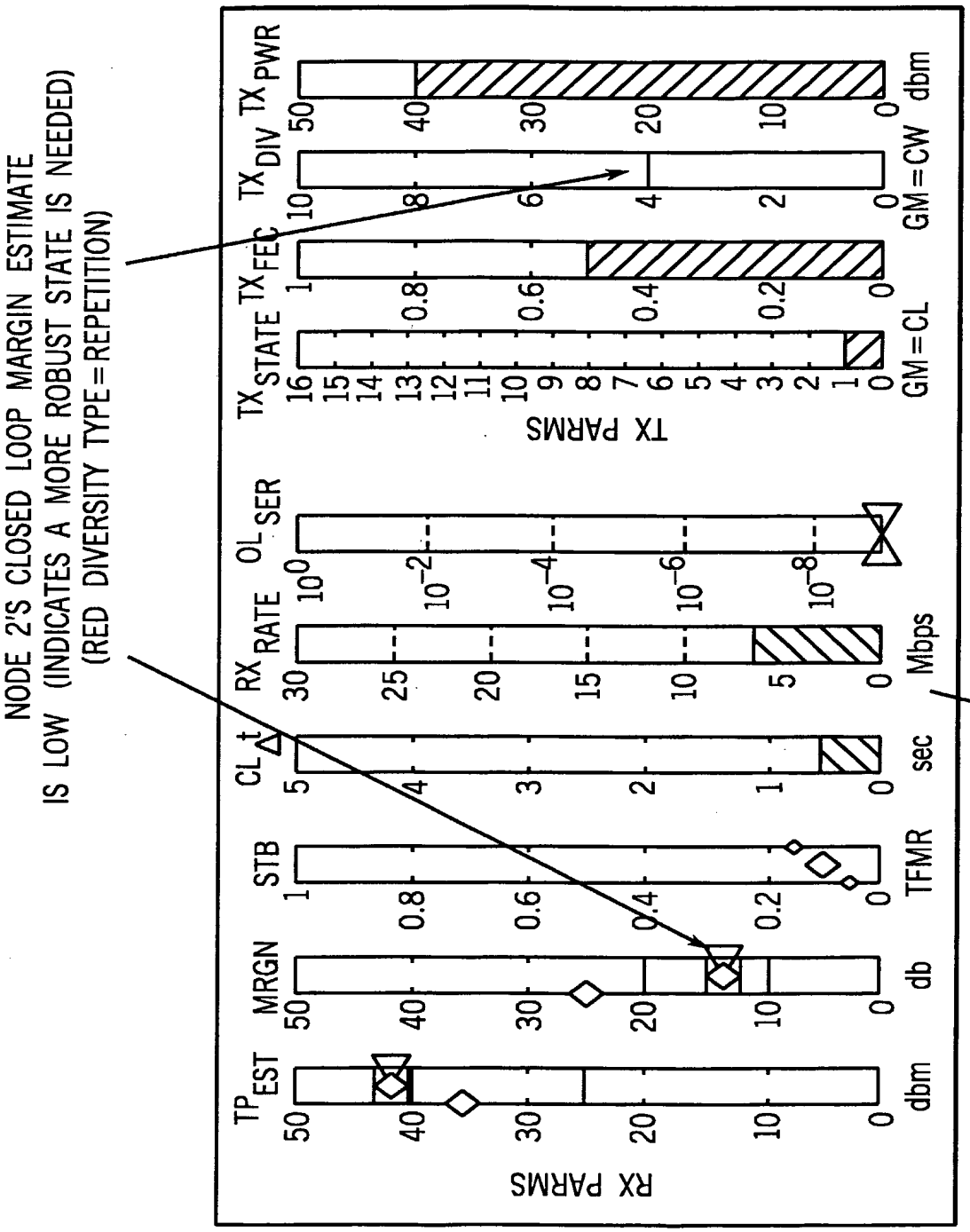
NODE 2'S CLOSED LOOP MARGIN ESTIMATE
IS LOW (INDICATES A MORE ROBUST STATE IS NEEDED)
(RED DIVERSITY TYPE=REPETITION)
TX PARMS
RX PARMS
TX PWR
TX DIV
TX FEC
TX STATE
GM=CW
GM=CL
dbm
OL SER
RX RATE
Mbps
CL Δt
sec
TFMR
STB
MRGN
db
TP EST
dbm
NODE 2
TO FIG. 12C

FIG. 12B

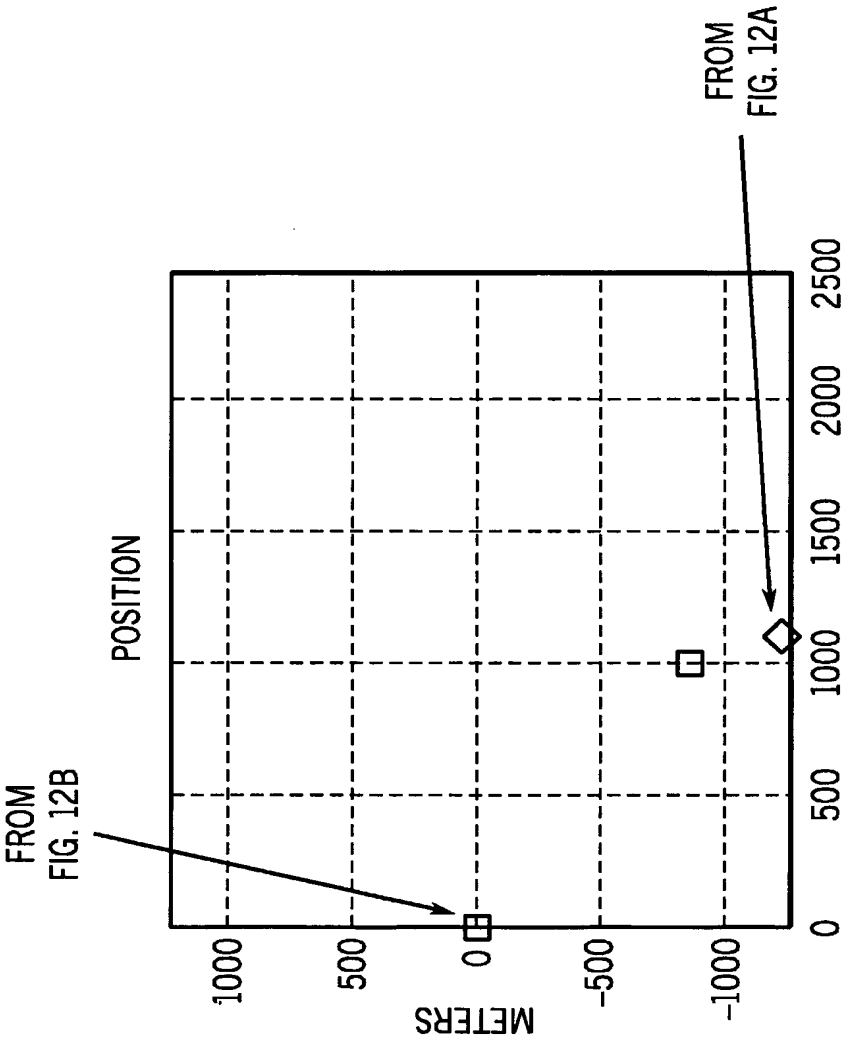
FROM FIG. 12A
FROM FIG. 12B
POSITION
METERS
1000
500
0
-500
-1000
METERS
0
500
1000
1500
2000
2500

FIG. 12C